Validation of the Dyop™ Visual Acuity Measure (A Pilot Study)

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Introduction and Background

For years the Snellen chart has been the standard visual acuity testing instrument used by eye care practitioners worldwide. Many attempts have been made to simplify visual acuity testing by modifying targets. The coming of the computer age has opened many doors to possible new ways to measure visual acuity and visual performance, but unfortunately most have simply computerized graphic images of the standard charts that were used before computers.

Allan Hytowitz has invented a new dynamic target called the Dyop which is computer generated using simple HTML 5.0 programming language. This promises to make its adoption easy. The Dyop is a spinning ring with small gaps. Mr. Hytowitz has done extensive testing of his new target but has yet to standardize it against the tried and true visual acuity measures that are currently in use by the eye care professions. This study will begin the process of revolutionizing the testing of visual acuity.

Research Objectives

The full study will look at 150 subjects and test them at threshold visual acuity on several standard eye charts as well as with the new Dyop. The goal of this study is to show that the Dyop is easy to use and that it is a valid measure of visual acuity.

Research Procedures

Subjects were seated in a standard examination chair 20 feet or 6M away from the targets, which were presented three different ways. The targets were presented using a standard projected chart letter target using either a halogen projector to a silvered screen setup or directly viewed on a computer monitor. Both the M&S Technologies Smart System II visual acuity system and the Dyop were viewed on the same computer monitor (Model: NEC EA221WM). Each of the targets was viewed through six different viewing conditions, all of which included the subject wearing their full correction as a base. The lens conditions were full correction alone and then with the following lenses placed over their habitual correction: +2.00 OU, +3.00 OU, +4.00 OU, and two Bangerter filters, marked 0.6 and 0.2. The order was randomized by chart and within chart by lens condition. In the pilot study six subjects were used. In the full study, which is currently in progress, 150 subjects have been recruited and tested.

What is a Dyop?

A Dyop (or Dynamic Optotype) is a uniformly rotating visual stimulus whose calibrated size, motion, color, and contrast provide a precise method for determining visual acuity. Dyops are not only more precise than static image acuity tests, but are faster to use, minimize memorization, and do not require the ability to read. Dyop images provide a universal measurement of visual acuity that is independent of literacy, age, language, and culture.

The calibrated Dyop image uses a combination of image diameter (angular arc width), segment/gap stroke width, circumferential rotation speed, color, contrast, and the pixelized strobic photoreceptor refresh rate to create an acuity threshold as an indicator for both visual acuity and the refraction end point. Unlike static images, which get increasingly blurry as they get smaller or further away, the rotation of Dyop images seems to disappear when they reach the acuity threshold. The precise Dyop diameter serves as an indicator of acuity based upon the angular arc width and viewing distance.

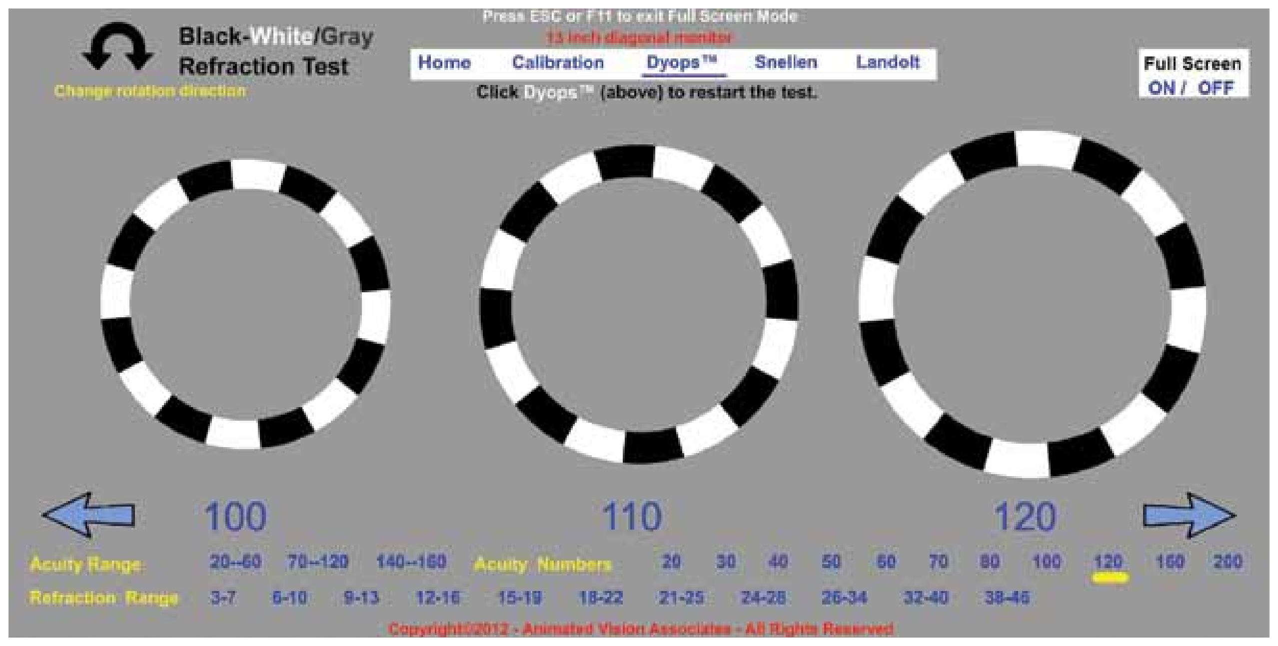

Figure 1 shows a screen with three Dyops on it ranging from 20/100 to 20/120. Each of the Dyops is rotating either clockwise or counter clockwise and the subject is asked to identify which direction the Dyop is rotating. The gray background is equiluminant with the average of the black and white segements of the Dyop. There is a great degree of sensitivity in measures with the Dyop, moving from clearly visible spinning to a uniform gray area in just a few Dyops.

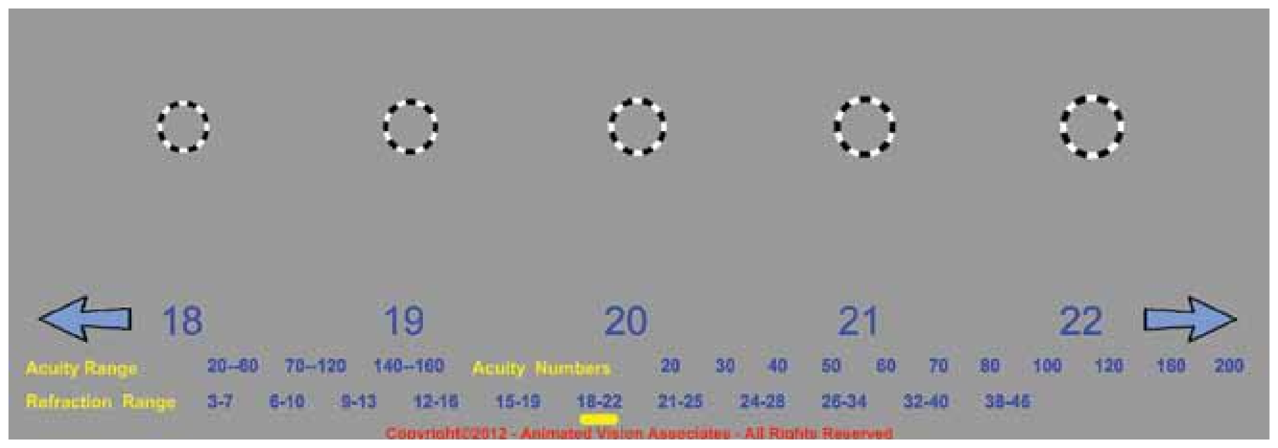

Figure 2 shows the variations in the Dyop down near the typical 20/20 threshold with gradations of 1 unit from Dyop to Dyop. In selecting the size to work with, the Acuity Range is first selected with the computer mouse on the second line from the bottom of the screen, with the finer degree being chosen on the bottom line. The arrows to the right and left of the screen allow the operator to shift easily to smaller or larger Dyops, and the spinning of the Dyop can be stopped or reversed at any time by the operator as well.

Results

The visual acuity measures taken for the six subjects at each of the testing conditions were averaged, and the results for the plus blur were plotted separately from the spatial frequency blur created by the Bangerter filters. It should be noted that the three scales have different steps in the visual acuity measures, leading to some measures being achievable on one chart but not on another. This becomes most evident in the higher blur conditions where the projected charts jump from 20/100 to 20/200 to 20/400, while the M&S Smart System II includes an extra step at 20/125 and the Dyop can be varied to much finer gradations.

Plus lenses, of the powers used in this study, when applied over full correction, cause a decrease in visual acuity on all charts. As can be seen from Figure 3, which is a combined table and graph, at threshold (around 20/20) all three charts give similar data; Dyop 20/21, M&S 20/17, Projected 20/17. With the +4.00 lenses on, the Dyop has only dropped to 20/113 while the projected chart has dropped to 20/243, a clinically significant difference.

Figure 4 shows what happens with the two Bangerter filters. The 0.6 filter removes only some of the higher spatial frequencies and therefore disrupts the visual acuity measures to a lesser degree than the 0.2 spatial frequency filter, which affects more spatial frequencies. In this instance the relative decrease is close enough to being the same at all points, allowing it to be said that the charts are all clinically the same.

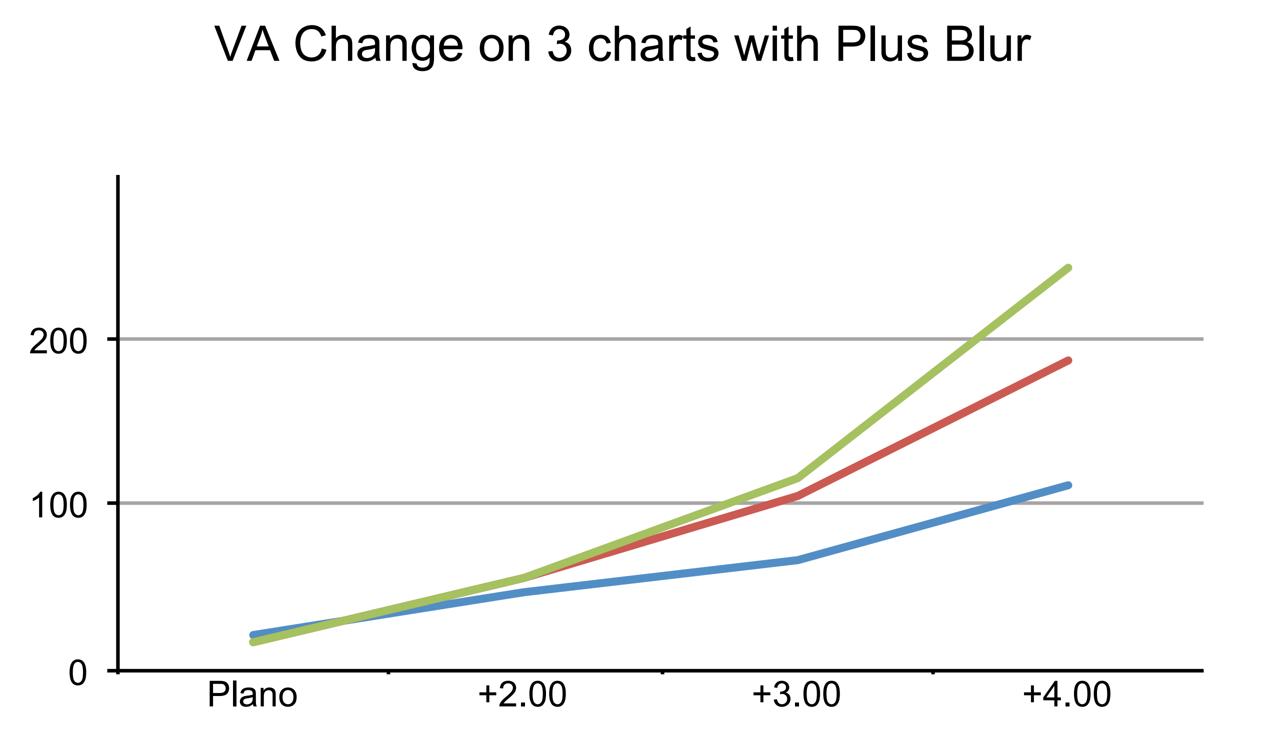

Figure 3 shows the results for the conditions of plus lens blur. It can be seen that plus lens blur does not decrease visual acuity to the same degree on the Dyop target as on the M&S computer based chart or as on the projected chart.

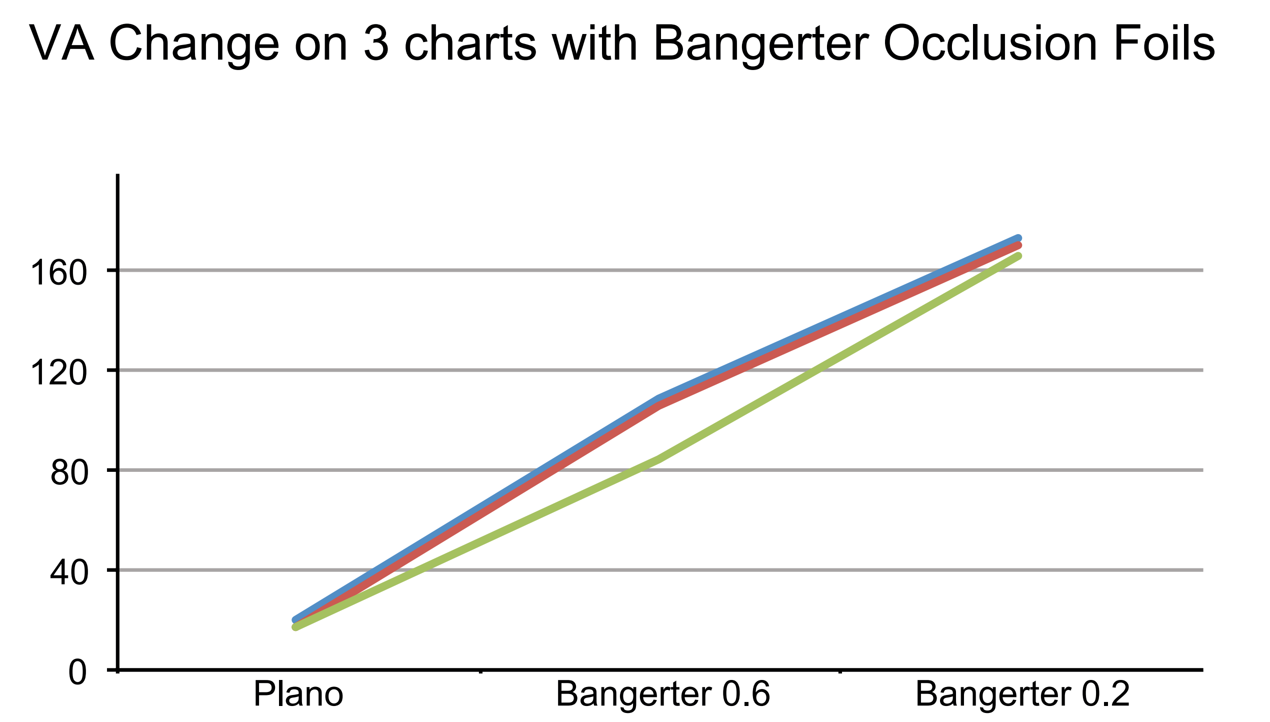

Figure 4 shows the changes in visual acuity secondary to the application of the Bangerter Filters over the subject's full correction.

Discussion

As in all cases of a pilot study it will be for the main study, with a much larger number of subjects, to determine whether the two main points which appear to have emerged here do indeed hold. If so, it also raises the level of interest here in finding out why the visual acuity drops off differently under the two different conditions: blur from plus lenses and blur from spatial frequency disruption. Might the two types of penalization decrease the visual acuity through different mechanisms? If so, what are those mechanisms? If they become understood, might this lead to a better understanding of conditions such as amblyopia and/or better and earlier diagnosis of conditions such as glaucoma or macular degeneration, to name just two?

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